Land Use Policy 77 (2018) 94–106

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Exploring the labour productivity of agricultural systems across European regions: A multilevel approach

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ARTICLE INFO

Keywords:
Agricultural labour productivity
Multilevel logistic regression model
Technical efficiency
Soil erosion
Farm education
Water limited yield potential

ABSTRACT

Agricultural productivity varies greatly among agricultural systems and among regions in Europe. A multilevel logistic regression model was applied to investigate the labour productivity of the six main agricultural systems across European NUTS2 regions. *K*-means and two-step clustering methods were used to classify European regions based on the agricultural systems' standard output per annual work unit. We analysed the effect of environmental (soil erosion, rainfed yield potential), structural (farm education, age, pluriactivity, diversification, rented agricultural land), technical (yield ratio) and contextual (gross domestic product per capita, population density) factors on labor productivity. Significant differences were revealed between northern-central regions and the continental peripheries (Mediterranean, Eastern). Soil erosion negatively affects agricultural labour productivity; for each one ton/ha increase in the modelled annual soil erosion rate the odds of regions to attain high labour productivity decreased by 28%. The importance of technical efficiency in crop production was also identified. Observed low wheat yields, relative to modelled potential yields, in the southern, eastern and northern European regions indicate a large unexploited gap. The positive effect of the regional gross domestic product per capita and the low population density confirmed the importance of contextual factors on labour productivity. A second analysis of a composite indicator of the labour productivity of the European agricultural systems, which accounted for the productivity of each system without considering its size, revealed the positive effect of farm education and the negative effect of pluriactivity on agricultural labour productivity. The analyses indicate the importance of compensatory allowances for areas facing natural constraints, while investing in farm training schemes and advisory services could increase the adoption of new technologies and improve the performance of farmers in both economic and environmental terms. Finally, the significance of contextual factors indicates the importance of a better harmonisation of rural development policy with regional policy.

1. Introduction

Agriculture is the main land user in the European Union (EU), accounting for 40% of its total land area, that is, 174.6 million hectare (Eurostat, 2017a). For several decades now, the number of farm holdings is continuously decreasing, while the farm size indicates a tendency towards larger holdings. The average farm size in the EU-27 increased from 11.5 ha in 2003 to 16.2 ha in 2013 (Eurostat, 2017a). Southern European countries (Spain, Italy, Greece, Portugal and Cyprus), i.e., those countries hit hardest by the recent economic crisis, showed relatively low rates of decline in the number of holdings between 2007 and 2013, e.g., Portugal -3.9% (Eurostat, 2017a), reflecting the ability of agriculture to form safety nets during periods of economic downturn (European Commission, 2013a ; Giannakis and Bruggeman, 2017a). On the contrary, eastern European countries exhibit the highest rates of decline in the number of farm holdings (e.g., Slovakia: −65.8%) (Eurostat, 2017a) as a result of the process of privatization and redistribution of agricultural land. The total agricultural labour force in the EU-27, expressed in annual work units (AWU), which includes and accounts for part-time and seasonal work, shrank by 34% between 2003 and 2013 (Eurostat 2017a; 2018); the average AWU per farm holding decreased from 0.91 in 2003 to 0.88 in 2013 (Eurostat 2017a, 2018). The agricultural jobs that remained in the sector have, however, become more productive: the average EU standard output (SO) generated per annual work unit, which can serve as a proxy for agricultural labour productivity, increased from 24,101 Euro in 2007 to 34,830 Euro in 2013 (at current prices) (Eurostat, 2017a). The most impressive increases of agricultural labour productivity between 2007 and 2013 took place in Slovakia (158%), Bulgaria (123%) and Latvia (112%) (Eurostat, 2017a).

The agricultural labour productivity varies greatly across Europe. Significant differences are revealed between the continental northern-

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https://doi.org/10.1016/j.landusepol.2018.05.037
Received 11 December 2017; Received in revised form 27 March 2018; Accepted 18 May 2018

central countries and the continental peripheries, i.e., the Mediterranean, Eastern Europe and Scandinavia. For example, Denmark has the highest standard output per annual work unit, that is, 155,717 Euro/AWU (2007-2013) followed by Belgium (120,674 Euro/AWU), while Romania (5958 Euro/AWU) and Bulgaria (6704 Euro/AWU) have the lowest (Eurostat, 2017a). The magnitude of the territorial asymmetries in labour productivity across the EU is significantly greater in agriculture than in the secondary and tertiary sectors (Ezcurra et al., 2008), constituting an impediment in achieving the territorial cohesion objectives, as designated in the Lisbon Treaty (European Commission, 2008a). The enhancement of agricultural productivity has been an overarching objective of the Common Agricultural Policy (CAP) over time, through financial support of farm restructuring and modernization (Hennis, 2005), while the large differences in agricultural productivity levels across European countries and regions is a challenge that CAP has faced from its establishment.

Agricultural productivity has been extensively studied at country level (Martín-Retortillo and Pinilla, 2015; Ball et al., 2001) and farm level (Helfand and Levine, 2004; Mugera et al., 2012), while significantly fewer studies focus on regional (Ezcurra et al., 2011; Smit et al., 2015) and local, i.e., municipal (Ženka et al., 2016) differences. Most studies at regional level explore how contrasting forces generate the observed "convergence" or "divergence" of agricultural productivity across regions (Esposti, 2011; Alexiadis et al., 2013). Relatively few studies have examined the labour productivity of individual farming systems at regional level and even fewer studies have employed a cross-regional analysis of the labour productivity of the different agricultural systems. For example, Veysset et al. (2015) studied the trend of labour productivity of suckler beef production systems in France and Manrique et al. (1999) explored the labour productivity of livestock farming systems in Pyrenees, Spain. Błażejczyk-Majka et al. (2011) analysed the labour productivity of field crop farms and mixed farms across 80 regions belonging to eleven old EU member states (EU-15) and four new EU member states (Czech Republic, Hungary, Poland, Slovakia). Limited is, however, the knowledge about the European inter-regional distribution of the labour productivity across agricultural systems.

A systems specific approach can allow a better understanding of the variability of productivity since it takes into account the well-known apples and oranges problem (Bernard and Jones, 1996). It is therefore of interest to investigate the labour productivity at both sectoral, that is, agricultural systems, and spatial, that is, regional level. In other words, to explore why labour or capital intensive agricultural systems yield high value added per labour unit in some regions, while in other regions they fail to do so.

The Commission Regulation (EC) No 1242/2008 describes in detail the typology of European agricultural holdings (European Commission, 2008b). The Regulation identifies eight specialist types of farming, namely, field crops (i.e., cereals, rice, dried pulses and protein crops, potatoes, sugar beet, tobacco and cotton), horticulture (i.e., vegetables and flowers), permanent crops (i.e., fruit plantations, olive plantations and vineyards), grazing livestock (i.e., cattle, sheep and goats), granivores (i.e., pigs, poultry and rabbits), mixed cropping (i.e., field crops and permanent crops, field crops and horticulture, horticulture and permanent crops), mixed livestock holdings (i.e., grazing livestock and granivores) and mixed crops-livestock (i.e., permanent crops and grazing livestock, field crops and grazing livestock, field crops and granivores). A holding's farming type is determined by the production system that makes up more than two-third of the total standard output of the holding.

Although there is no unique set of physical, technical and human capital factors and conditions that enhance agricultural labour productivity, it is, however, possible to identify common patterns for attaining high economic output per labour unit in agriculture. A separate analysis of the determinants of the labour productivity of the European agricultural systems would be ideal to reveal sectors' comparative advantages. However, there are no system-specific data at regional level that allow the quantification of such effects. Within this context, the objectives of this paper are: (a) to identify the differences in the labour productivity of agricultural systems across European countries and regions; (b) to investigate the factors that influence agricultural labour productivity; (c) to discuss the policy implications related with the significance and magnitude of those factors.

2. Methodology

2.1. Agricultural productivity data

Within this study, we analyse the labour productivity of six agricultural systems: (a) field crops, (b) horticulture, (c) permanent crops, (d) grazing livestock, (e) granivores, and (f) mixed crop-livestock. The two subgroups of the mixed livestock holdings system, namely, the mixed livestock – mainly grazing livestock, and the mixed livestock – mainly granivores, were combined with the grazing livestock and the granivores farming systems, respectively. Additionally, the mixed cropping agricultural system was omitted from our analysis due to its small share in the EU-28 (3% in terms of SO and 5% in terms of AWU).

The data used in the analysis of the labour productivity of agricultural systems of the NUTS2 regions are the official EU Farm Structural Surveys (FSS) data (Eurostat, 2017b). These surveys are carried out every three or four years as a sample survey (e.g., 2007 and 2013), and once in ten years as a census (e.g., 2010). The FSSs provide comparable and representative statistics across countries and regions and time and this information is used as a basis for decision making in the CAP. The representativeness and reliability of FSSs at the level of NUTS2 regions and by farm type is described in the Regulation (EC) No 1166/2008 (European Commission, 2008c).

A summary of the farm structure statistics (standard output, annual work units, utilized agricultural area and livestock units) of the six farming systems and derived productivity indicators, at the EU and country level, is presented in Section 3.1. Correlations between the labour productivity and the agricultural area or livestock units of the agricultural systems at the country level are computed.

2.2. Explanatory variables

The explanatory variables of the model can be classified into four broad categories, including farm structural factors (farmer and farm holding characteristics), environmental factors, technical factors and contextual factors. The variables were averaged across a six-year period (2007-2013) to mitigate potential year-specific effects in agricultural labour productivity caused by production and price fluctuations, except for the environmental and technical factors, as explained below. The reference spatial unit for the cross-regional empirical analysis is NUTS2 regions. In the case of Germany, we used the data of the NUTS1 regions due to constraints in data availability at NUTS2 level. Table 1 presents the definitions and the descriptive statistics of all variables used in the analysis.

The first two factors, namely, age and farm education, represent two human capital aspects of the farm population. The age of the farm population is expressed as the share of farmers older than 55 years. The age (AGE) is commonly related to farmers' managerial skills and aptitude to innovate, adopt modern farm practices and technologies and gain funding opportunities (Ezcurra et al., 2011). The farm education (FEDUC) is expressed as the share of farm managers with basic or full agricultural training. A better trained farm population facilitates the introduction of technical innovation, the absorption of externally generated knowledge and plays an important role in the adaptation of the sector to climate change (Vecchione, 2010; Giannakis et al., 2016). Farmers' engagement in other gainful activity other than farm work (PLUR) is an important adaptation strategy to cope with market pressures (Weltin et al., 2017; Giannakis et al., 2018) and can have either